Time

(1) Our experience of time comprises such subjective phenomena as: simultaneity, successiveness, temporal order, subjective present, temporal continuity and subjective duration (Pöppel, 1997).
(2) "Positions in time" [temporal order] can be conceived in two differing ways: as a relation between two events (earlier/later; B-series; sequential) or as a relation between three events (past/present/future; A-series; deictic) (McTaggart, 1908).
(3) Time can be conceived from an internal (egocentric) or external (allocentric) point of view of the observer (Núñez & Cooperrider, 2013).
(4) Time is an abstract concept, for which we have (thus far) found no dedicated sensory organ (Block, 1990; Hancock & Block, 2012).

Thinking about time (Conceptual Metaphor)

(5) In language, we employ a number of metaphors to express ideas about time (Lakoff & Johnson, 1980).
(6) Abstract domains (such as time) are structured through metaphorical mappings from domains grounded directly in physical experience (such as space) (Boroditsky, 2000).
(7) According to the *Metaphoric Structuring View*, aspects of time that are relevant to space will be shaped by the metaphors utilized (Boroditsky, 2000).
(8) The *weak view of metaphoric structuring* posits that, with frequent use, spatial metaphors become established in the representation of the domain of time, so spatial schemas may no longer be accessed when thinking about time (Boroditsky, 2000).
(9) Empirical evidence suggests that spatial primes (of movement metaphors) can effectively influence how individuals think about time (Boroditsky, 2000).
(10) Empirical evidence suggests that individuals automatically recruit "culturally suggested" representations of time, even when performing non-linguistic tasks (card sort, early/later judgments of pictures) (Fuhrman & Boroditsky, 2010).
(11) Humans use *mental metaphors* that may correspond to linguistic metaphors, in order to conceptualize abstract domains, even when not using language (Casasanto, 2010).

Conceptual flexibility (Coherent Working Models Theory)

(12) Culturally suggested spatial representations of time are the product of: linguistic metaphors, writing direction, and cultural artifacts (Núñez & Cooperrider, 2013).
(13) Temporal metaphors show an impressive degree of flexibility within and across individuals, languages and cultures (Santiago, Román, & Ouellet, 2011).
(14) There is a dearth of linguistic metaphors for directionality of time; however, there are metaphors in cultural artifacts, including reading direction, calendars, and the typical layout of graphs (Santiago et al., 2011).
(15) New conceptual metaphors can be acquired at an impressive speed (Santiago et al., 2011).
(16) Some of the factors that mediate the manifestation of one or another conceptual mapping are: the relevance of an attended supporting context (priming), habitual exposure, use of linguistic expressions, and graphic cultural conventions (Santiago et al., 2011).
(17) According to the Coherent Working Models Theory, "Inconsistent metaphoric mappings for a given domain may coexist in semantic memory and be activated in different situations and by different reasons, but not at the same time, as this would lead to the generation of internally inconsistent mental models." (Torralbo, Santiago, & Lupiáñez, 2006)

Temporal Reasoning (Mental Models)

(18) Temporal sequence – the order of events – is the most basic requirement for causation (Johnson-Laird, 1999)

(19) During information processing, humans create small-scale models of the world, consisting of mental images and complex abstract structures (Johnson-Laird, 1999)[(modern) mental model theory of reasoning]

(20) To reason about sequences of events, individuals use their general knowledge, combined with their knowledge of language, to generate mental models of events. This view of reasoning is in contrast to that of a logical calculus, where individuals follow a series of learned mental rules (Schaeken & Johnson-Laird, 1995) //the mental model approach to reasoning was largely inspired by research in artificial intelligence which sought to replicate results of behavioral experiments on reasoning performance.

(21) "The theory makes two main predictions. First, the more alternative models that have to be constructed in order to draw a correct conclusion, the longer the task should take, and the greater the chance of error should be. Second, erroneous conclusions should tend to be consistent with the premises rather than inconsistent with them. Such conclusions arise because reasoners are likely to base them on at least some model of the premises but overlook other possible models." (Schaeken & Johnson-Laird, 1995)

References

Block, R. A. (1990). Models of Psychological Time. In R. A. Block (Ed.), *Cognitive models of psychological time* (pp. 1–35). Hillsdale , NJ: Lawrence Erlbaum Associates.

Boroditsky, L. (2000). Metaphoric structuring: understanding time through spatial metaphors. *Cognition*, *75*(1), 1–28. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10815775

Casasanto, D. (2010). Space for thinking. In V. Evans & P. Chilton (Eds.), *Language, cognition and space: The state of the art and new directions* (pp. 453–478). Equinox. Retrieved from http://lingo.stanford.edu/sag/papers/Casasanto_forthcoming.pdf

Fuhrman, O., & Boroditsky, L. (2010). Cross-cultural differences in mental representations of time: evidence from an implicit nonlinguistic task. *Cognitive Science*, *34*(8), 1430–51. doi:10.1111/j.1551-6709.2010.01105.x

Hancock, P. A., & Block, R. A. (2012). 125th Anniversary Articles The Psychology of Time : A View Backward and Forward. *American Journal of Psychology*, *125*(3), 267–274.

Johnson-Laird, P. N. (1999). Causation, Mental Models, and the Law. *Brooklyn Law Review*, (c), 1–31.

Lakoff, G., & Johnson, M. (1980). *Metaphors We Live By* (1st ed.). Oxford University Press. doi:978-0226468013

McTaggart, J. (1908). The unreality of time. *Mind*, *17*, 456–473. Retrieved from http://www.jstor.org/stable/2248314

Núñez, R., & Cooperrider, K. (2013). The tangle of space and time in human cognition. *Trends in Cognitive Sciences*, *17*(5), 220–9. doi:10.1016/j.tics.2013.03.008

Pöppel, E. (1997). A hierarchical model of temporal perception. *Trends in Cognitive Sciences*, *1*(2), 56–61. doi:10.1016/S1364-6613(97)01008-5

Santiago, J., Román, A., & Ouellet, M. (2011). Flexible foundations of abstract thought: A review and a theory. In T. W. Schubert & A. Maass (Eds.), *Applications of Cognitive Linguistics: Spatial dimensions of social thought*. Berlin: Walter de Gruyter. Retrieved from http://books.google.com/books?hl=en&lr=&id=gUQc8EFx85MC&oi=fnd&pg=PA39&dq=Flexible+foundatio

ns+of+abstract+thought:+A+review+and+a+theory&ots=yHQnsfNuek&sig=aLA35KsnKR388uju7PWdaQ9jaJM

Schaeken, W., & Johnson-Laird, P. N. (1995). Mental models and temporal reasoning. *Cognition*, *60*(96), 205–234.

Torralbo, A., Santiago, J., & Lupiáñez, J. (2006). Flexible conceptual projection of time onto spatial frames of reference. *Cognitive Science*, *30*(4), 745–57. doi:10.1207/s15516709cog0000_67